3.5 More Real World Problems

1. Mr. Smith, a school custodian, is on the roof of the local elementary school throwing tennis balls to the students below. The height of each tennis ball can be modelled by $h(t) = -4.9(t+1)(t-3)$, where h(t) is the height of the ball above the ground, in metres, and t is the time the ball is in the air, in seconds.

a) From what height is Mr. Smith throwing the tennis balls?
b) Find the maximum height of a tennis ball and the time it takes to reach this height.
c) Determine the time when a tennis ball hits the ground, to the nearest tenth of a second.
d) Sketch a graph of the path of the tennis ball. Label key features.
e) Chris, a grade 4 student, is watching Mr. Smith throw down the tennis balls. Chris is 1 m tall and can reach as high as 1.5 m. Will he be able to catch the ball 0.5 seconds before it lands? Explain.

2.The under side of a bridge is has the shape of a parabolic arch. Its has a maximum height of 30 m and a width of 50m.
a) Determine an algebraic expression that models the underside of the bridge.
b) Can a sailboat with a mast of 27 m above the water pass under the bridge at a distance of 8 m from the axis of symmetry of the arch? (justify your solution)

3. An underground silo contains a rocket which releases a weather balloon after the rocket reaches its maximum height. The rocket then plummets back to Earth. The height of the rocket is modelled by $h(t) = -4.9t^2 + 529.2t - 50$, where h(t) is the height of the rocket, in metres, and t is the time, in seconds.

a) At what height is the weather balloon released? At what time does this occur?
b) At what time is the rocket first above ground, to the nearest tenth of a second?
c) After how many seconds does the rocket land back on Earth, to the nearest tenth of a second?
d) How far below ground is the silo?
e) State the domain and range as it applies to this situation.
f) Sketch a graph of the path of the rocket. Label key features.

4. In the following DC electrical circuit, the relationship between the power used by a device, P (in watts, W), the electric potential difference (voltage), V (in volts, V), the current, I (in amperes, A), and the resistance, R (in ohms, Ω), is represented by the formula

$P = IV - I^2R$

a) Represent graphically (sketch) and algebraically the relationship between the power and the current when the electric potential difference is 24 V and the resistance is 1.5 Ω.
b) Determine the current needed in order for the device to use the maximum amount of power.

Answers:

1. a) 14.7m b) 19.6m, 1 sec c) 3 sec e) No, the ball is still 8.6 m above the ground.
2. a) (Answers may vary) $h(d) = -\frac{6}{125}(d-25)^2 + 30$ b) no, the height of the arch at this point is approx 26.9 m
3.a) approx 14 238.4 m occurring at 54 sec b) approx 0.1 sec c) approx 1min 47.9 sec d) 50 m
e) $D=\{t \in R / 0 \le t \le 107.9\}$ $R=\{h(t) \in R / -50 \le h(t) \le 14238.4\}\}$ 4. a) $P = 24I - 1.5I^2$ zeros: 0 A and 16 A
b) current needed is 8 A and max power is 96 W